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(54) Title: FLUOROCARBON REFRIGERANT COMPOSITIONS

(57) Abstract: The invention provides fluorocarbon refrigerant compositions that offer alternatives, and are considered environmentally safe substitutes, for CFC's and HCFC's. The compositions of the invention are useful as refrigerants, including for use in chillers, aerosol propellants, metered dose inhalers, heat transfer media, gaseous dielectrics, fire extinguishing agents, foam blowing agents, solvents and sterilants. The compositions of the invention are soluble in lubricating oils and are, therefore, particularly useful as R-22 retrofit fluids.

polyol ester lubricants. In retrofitting refrigerant systems with hydrofluorocarbon refrigerants it is necessary to drain as much of the oil as possible before adding the replacement lubricant. Often this entails removing the compressor from the system to drain lubricant. A chlorine-free R-22 retrofits that is soluble in lubricating oil would advance the art.

The use of fluorocarbon based fluids in sterilant mixtures is known. See, for example, U.S. Patent Nos. 5,976,554; 5,376,333; 4,976,922; 5,039,484; 5,039,485; 5,342,579; and 5,254,309, herein incorporated by reference in their entirety.

The use of fluorocarbon based fluids as blowing agents is known. See, for example, U.S. Patent Nos. 5,946,866; 5,688,833; 5,759,438; and 5,925,612, herein incorporated by reference in their entirety.

The use of fluorocarbon based fluids as solvents is known. See, for example, U.S. Patent Nos. 5,219,490; and 4,842,764, herein incorporated by reference in their entirety.

The use of fluorocarbon based fluids as fire extinguishing agents is known. See, for example, U.S. Patent Nos. 5,918,680; 4954,271; 5,135,054 and 5,135,054; herein incorporated by reference in their entirety.

The use of fluorocarbon based fluids as aerosol propellants and in metered dose inhalers is known. See, for example, U.S. Patent Nos. 6,013,245; 5,891,419; and 5,858,331, herein incorporated by reference in their entirety.

Summary of the Invention

The invention provides fluorocarbon refrigerant compositions that offer alternatives, and are considered environmentally safe substitutes, for CFC's and HCFC's.

The compositions of the invention are soluble in lubricating oils and are, therefore, particularly useful as R-22 retrofit fluids.

The compositions of the invention comprise a refrigerant and a solubilizing agent. Preferably the refrigerant is a hydrofluorocarbon refrigerant. Optionally, the compositions of the invention further comprise a lubricating oil selected from the group consisting of mineral or hydrocarbon oil, alkyl benzene oil, white or paraffinic oil and mixtures thereof.

In one embodiment of the invention, there is provided a composition comprising a refrigerant selected from the group consisting of the compounds listed in Table 1 and mixtures thereof and at least one solubilizing agent selected from the group consisting of the compounds listed in Table 2 and mixtures thereof.

In another embodiment, there is provided a composition comprising (i) from about 80 to about 99.9 weight percent, preferably from about 90 to about 99.9 weight percent, of a refrigerant selected from the compounds listed in Table 1 and mixtures thereof; and (ii) from about 20 to about 0.1 weight percent, preferably from about 10 to about 0.1 weight percent, of a solubilizing agent selected from the compounds listed in Table II and mixtures thereof.

In yet another embodiment of the invention, there is provided a composition comprising (i) from about 80 to about 99.9 weight percent, preferably from about 90 to about 99.9 weight percent, of a refrigerant selected from Table III; and (ii) from about 20 to about 0.1 weight percent, preferably from about 10 to about 0.1 weight percent, of a solubilizing agent selected from the compounds listed in Table II and mixtures thereof.

In still another preferred embodiment, there is provided a composition comprising (i) from about 80 to about 99.9 weight percent, preferably from about 90 to about 99.9 weight percent, of a refrigerant selected from Table IV; and (ii) from about 20 to about 0.1 weight percent, preferably from about 10 to about 0.1 weight percent, of a solubilizing agent selected from the compounds listed in Table II and mixtures thereof.

In a particularly preferred embodiment, there is provided a composition comprising (i) from about 80 to about 99.9 weight percent, preferably from about 90 to about 99.9 weight percent, of a refrigerant selected from the group consisting of

R-407C, R-410A, R-404A and R-507A; and (ii) from about 20 to about 0.1 weight percent, preferably from about 10 to about 0.1 weight percent, of a solubilizing agent selected from the group consisting of butane, isobutane, pentane, dimethyl ether, and mixtures thereof.

When a lubricating oil is present, it is present in an amount of from about 1 to about 60 weight percent, preferably from about 10 to about 50 weight percent, based on the total composition.

In a process embodiment, there is provided a method for producing refrigeration which comprises condensing a composition of the invention and thereafter evaporating the composition in the vicinity of a body to be cooled.

In another process embodiment, there is provided a method for producing heating which comprises condensing a composition of the invention in the vicinity of a body to be heated and thereafter evaporating the composition.

In another embodiment, the compositions of the invention may be used in centrifugal chillers. By "centrifugal chillers" is meant refrigeration equipment that uses centrifugal compression to compress the refrigerant. The invention provides a method for producing refrigeration using a centrifugal compressor comprising compressing a refrigerant comprising the compositions of the invention and thereafter evaporating the refrigerant in the vicinity of a body to be cooled

In still another embodiment, the compositions of the invention may be used in a method for producing foam comprising blending a heat plasticized resin with a volatile bowing agent comprising the compositions of the invention and introducing the resin/volatile blowing agent blend into a zone of lower pressure to cause foaming.

In another process embodiment, the compositions of the invention are used in a method for producing polyurethane and polyisocyanurate foams. Any of the methods well known in the art such as those described in "Polyurethanes Chemistry and Technology," Volumes I and II, Saunders and Frisch, 1962, John Wiley and Sons, New York, NY. In general, the method comprises preparing polyurethane or polyisocyanurate foams by combining an isocyanate, a polyol or mixture of polyols, a

blowing agent or mixture of blowing agents, and other materials such as catalysts, surfactants, and optionally, flame retardants, colorants, or other additives. The blowing agent or agents employed shall be a volatile mixture of the compositions of the present invention.

It is convenient in many applications to provide the components for polyurethane or polyisocyanurate foams in preblended formulations. Most typically, the foam formulation is preblended into two components. The isocyanate and optionally certain surfactants and blowing agents comprise the first component, commonly referred to as the "A" component. The polyol or polyol mixture, surfactant, catalysts, blowing agents, flame retardant, and other isocyanate reactive components comprise the second component, commonly referred to as the "B" component. Accordingly, polyurethane and polyisocyanurate foams are readily prepared by bringing together the A and B side components either by hand mix for small preparations and, preferably, machine mix techniques to form blocks, slabs, laminates, pour-in-place panels and other items, spray applied foams, froths, and the like. Optionally, other ingredients such as fire retardants, colorants, auxiliary blowing agents, water, and even other polyols can be added as a third stream to the mix head or reaction site. Most conveniently, however, they are all incorporated into one B component as described above.

The compositions of the invention may also be used as heat transfer fluids. For example, in certain refrigeration systems, it is desirable to operate the system at a specific temperature. However, maintaining the desired temperature may require either the addition or removal of heat. Thus, a secondary heating loop containing an appropriate heat transfer fluid may be added. The heat transfer fluid absorbs heat in one part of the cycle and transfers the heat to another part of the cycle without changing state, when the heat transferred is sensible, or by changing state, when the heat transferred is latent.

In another embodiment, the mixtures and compositions of this invention may be used as propellants in sprayable compositions, either alone or in combination with known propellants. The sprayable composition comprises, consists essentially of, and

consists of a material to be sprayed and a propellant comprising, consisting essentially of, and consisting of a mixture or composition of the invention. Inert ingredients, solvents, and other materials may also be present in the sprayable mixture. Preferably, the sprayable composition is an aerosol. Suitable materials to be sprayed include, without limitation, cosmetic materials such as deodorants, perfumes, hair sprays, cleansers, and polishing agents as well as medicinal materials such as anti-asthma and anti-halitosis medications.

The compositions of the invention may also be used in a method of dissolving contaminants or removing contaminants from the surface of a substrate, which method comprises the step of contacting the substrate with the compositions of the present invention.

In another embodiment, the compounds and mixtures of the present invention may also be used as fire extinguishing agents.

Detailed Description

The refrigerant may comprise any one of the compounds listed in Table I or mixtures of two or more thereof. Hydrofluorocarbon refrigerants are preferred. The term hydrofluorocarbon refers to compounds composed solely of carbon, hydrogen and fluorine atoms. Of the hydrofluorocarbon refrigerants listed in Table I, R-32, R-143a, R-125, R-134a and mixtures thereof are preferred.

Refrigerant mixtures are preferred. Representative refrigerant mixtures are listed in Table III. Hydrofluorocarbon refrigerant mixtures are preferred. Of the hydrofluorocarbon refrigerant mixtures listed in Table III, R-404A, R-407C, R-410A and R-507A are preferred. Hydrofluorocarbon refrigerant mixtures selected from Table IV are also preferred.

As used herein, the term solubilizing agent refers to a compound that increases the solubility of a hydrofluorocarbon refrigerant and a lubricating oil in one another. It will be understood that the solubilizing agent may comprise any one of the compounds listed in Table II or mixtures of two or more thereof. Butane, isobutane

and dimethyl ether are preferred. The amount of solubilizing agent is an amount effective to dissolve a sufficient amount of refrigerant in the lubricating oil such that the diluted oil can be transported back to the refrigeration compressor. Typically, the solubilizing agent is present in an amount of from about 0.1 to about 20 weight percent, preferably from about 0.1 to about 10 weight percent, based on the total composition.

As used herein, the term lubricating oil refers to mineral or hydrocarbon oil; alkyl benzene oil; white or paraffinic oil; and mixtures thereof. Suitable lubricating oils are commercially available from various sources (e.g., Capella brand names from Texaco and Suniso brand names from Sun Oil). The chemical compositions and uses of these oils are discussed in detail in the book "Fluorocarbon Refrigerants Handbook" by Ralph C. Downing, Prentice Hall, 1998, pp. 206-270. The amount of lubricating oil is an amount effective to provide acceptable lubrication to the compressor parts for its longevity. An effective amount of lubricating oil is the amount recommended by the equipment manufacturer. Typically, the lubricating oil is present in an amount of from about 1 to about 60 weight percent, preferably from about 10 to about 50 based on the total composition.

Table I: Refrigerants

Refrigerant Number	Chemical Name	Chemical Formula
Methane Series		
11	Trichlorofluoromethane	CCl_3F
12	Dichlorodifluoromethane	CCl_2F_2
13	Chlorotrifluoromethane	$CClF_3$
14	Tetrafluoromethane (carbon tetrafluoride)	CF_4
21	Dichlorofluoromethane	$CHCl_2F$
22	Chlorodifluoromethane	$CHClF_2$
23	Trifluoromethane	CHF_3
30	Dichloromethane (methylene chloride)	CH_2Cl_2
31	Chlorofluoromethane	CH_2ClF
32	Difluoromethane (methylene fluoride)	CH_2F_2
40	Chloromethane (methylene fluoride)	CH_2F_2
41	Fluoromethane (methyl fluoride)	CH_3F
Ethane Series		
113	1,1,2-trichloro-1,2,2-trifluoroethane	CCl_2FCClF_2
114	1,2-dichloro-1,1,2,2-tetrafluoromethane	$CClF_2CClF_2$
115	Chloropentafluoroethane	$CClF_2CF_3$
116	Hexafluoroethane	CF_3CF_3
123	2,2-dichloro-1,1,1,-trifluoroethane	$CHCl_2CF_3$
124	1-chloro-1,1,1,2-tetrafluoroethane	$CHClFCF_3$
125	Pentafluoroethane	CHF_2CF_3
134a	1,1,1,2-tetrafluoroethane	CH_2FCF_3
141b	1,1-dichloro-1-fluoroethane	CH_3CCl_2F
142b	1-chloro-1,1-difluoroethane	CH_3CClF_2
143a	1,1,1-trifluoroethane	CH_3CF_3
152a	1,1-difluoroethane	CH_3CHF_2
Propane Series		
218	Octafluoropropane	CF3CF2CF3
227ea	1,1,1,2,3,3,3-heptafluoropropane	CF_3CHFCF_3
236fa	1,1,1,3,3,3-hexafluoropropane	$CF_3CH_2CF_3$
245fa	1,1,1-3,3-pentafluoropropane	$CF_3\,CH_2CHF_2$
Butane Series		
365	1,1,1,3,3-pentafluorobutane	$CF_3CH_2CF_2CH_3$
Cyclic Organic Compounds		
C318	Octafluorocyclobutane	$-(CF_2)_4-$

Table II: Solubilizing Agents

Refrigerant Number	Chemical Name	Chemical Formula
Miscellaneous Organic Compounds		
Hydrocarbons		
30	Dichloromethane (methylene chloride)	CH_2Cl_2
40	Chloromethane (methyl chloride)	CH_3Cl
50	Methane	CH_4
170	Ethane	CH_3CH_3
290	Propane	$CH_3CH_2CH_3$
600	Butane	$CH_3CH_2CH_2CH_3$
600a	Isobutane	$CH(CH_3)_2CH_3$
---	Pentane	$CH_3(CH_2)_3CH_3$
---	Isopentane	$CH_3CH(CH_3)CH_2CH_3$
---	Neopentane	$CH_3C(CH_3)_2CH_3$
---	Cyclopentane	$-(CH_2)_5-$
Fluorocarbons		
13I1	Iodotrifluoromethane	CF_3I
---	Pentafluorodimethyl ether	CF_2OCF_2H
152a	1,1-difluoroethane	CH_3CHF_2
161	Fluoroethane	CH_3CH_2F
218	Hexafluoroethane	CF_3CF_3
Oxygen compounds		
---	Dimethyl ether	CH_3OCH_3
610	Ethyl ether	$CH_3CH_2OCH_2CH_3$
---	Poly butylene glycols	$H-(O-CH_3CH_2CH_2CH_3)_n-OH$
611	Methyl formate	$HCOOCH_3$
Inorganic Compounds		
744	Carbon dioxide	CO_2
764	Sulfur hexafluoride	SF_6
Unsaturated Organic Compounds		
1150	Ethene (ethylene)	$CH_2=CH_2$
1270	Propene (propylene)	$CH_3CH=CH_2$

Table III: Refrigerant Mixtures

Refrigerant Number	Composition (Wt.%)
Zeotropes	
400	R-12/114 (40/60)
401A	R-22/152a/124 (53/13/34)
401B	R-22/152a/124 (61/11/28)
401C	R-22/152a/124 (33/15/52)
402A	R-125/290/22 (60/2/38)
402B	R-125/290/22 (38/2/60)
403A	R-290/22/218 (5/75/20)
403B	R-290/22/218 (5/56/39)
404A	R-125/143a/134a (44/52/4)
405A	R-22/152a/142b/C318 (45/7/5.5/42.5)
406A	R-22/600a/142b (55/4/41)
407A	R-32/125/134a (20/40/40)
407B	R-32/125/134a (10/70/20)
407C	R-32/125/134a (23/25/52)
407D	R-32/125/134a (15/15/70)
407E	R-32/125/134a (25/15/60)
408A	R-125/143a/22 (7/46/47)
409A	R-22/124/142b (60/25/15)
409B	R-22/124/142b (65/25/10)
410A	R-32/125 (50/50)
410B	R-32/125 (45/55)
411A	R-1270/22/152a) (1.5/87.5/11.0)
411B	R-1270/22/152a (3/94/3)
412A	R-22/218/143b (70/5/25)
413A	R-218/134a/600a (9/88/3)
414A	R-22/124/600a/142b (51/28.5/4/16.5)
414B	R-22/124/600a/142b (50/39/1.5/9.5)
Azeotropes	
500	R-12/152a (73.8/26.2)
501	R-22/12 (75.0/25.0)
502	R-22/115 (48.8/51.2)
503	R-23/13 (40.1/59.9)
504	R-32/115 (48.2/51.8)
505	R-12/31 (78.0/22.0)
506	R-31/114 (55.1/44.9)
507A	R-125/143a (50/50)
508A	R-23/116 (39/61)
508B	R-23/116 (46/54)
509A	R-22/218 (44/56)

Table IV: Hydrofluorocarbon Refrigerant Mixtures

Mixture #	R-32 wt.%	R-125 wt.%	R-143a wt.%	R-134a wt.%
1	10 to 80	90 to 20	-	-
2	5 to 45	5 to 45	-	90 to 10
3	-	30 to 90	70 to 10	-
4	-	60 to 40	39 to 20	2 to 40

The compositions of the present invention may comprise any specific combination of any one or more refrigerants listed in Table I, Table III, and/or Table IV with any one or more solubilizing agents listed in Table II. Therefore, each and every possible specific combination of listed refrigerants and solubilizing agents is considered independently enabled as an embodiment of the present invention.

The components of the composition of the invention are known materials that are commercially available or may be prepared by known methods. Preferably, the components are of sufficiently high purity so as to avoid the introduction of adverse influences on the properties of the system.

The compositions of the invention may also contain additives such as oxidation resistance and thermal stability enhancers, corrosion inhibitors, metal deactivators, lubricity additives, viscosity index enhancers, pour and/or floc point depressants, detergents, dispersants, antifoaming agents, anti-wear agents, and extreme pressure resistant additives. Many additives are multifunctional. For example, certain additives may impart both anti-wear and extreme pressure resistance properties, or function both as a metal deactivator and a corrosion inhibitor. Cumulatively, all additives preferably do not exceed 8% by weight, or more preferably do not exceed 5% by weight, of the total composition.

An effective amount of the foregoing additive types is generally in the range from 0.01 to 5% for the antioxidant component, 0.01 to 5% for the corrosion inhibitor component, from 0.001 to 0.5% for the metal deactivator component, from 0.5 to 5% for the lubricity additives, from 0.01 to 2% for each of the viscosity index enhancers and pour and/or floc point depressants, from 0.1 to 5% for each of the detergents and dispersants, from 0.001 to 0.1% for anti-foam agents, and from 0.1-2% for each of the

anti-wear and extreme pressure resistance components. All these percentages are by weight and are based on the total composition. It is to be understood that more or less than the stated amounts of additives may be more suitable to particular circumstances, and that a single molecular type or a mixture of types may be used for each type of additive component. Also, the examples listed below are intended to be merely illustrative and not limiting.

Examples of suitable oxidation resistance and thermal stability enhancers are diphenyl-, dinaphthyl-, and phenylnaphthyl-amines, in which the phenyl and naphthyl groups can be substituted, e.g., N,N'-diphenyl phenylenediamine, p-octyldiphenylamine, p,p-dioctyldiphenylamine, N-phenyl-1-naphthyl amine, N-phenyl-2-naphthyl amine, N-(p-dodecyl)phenyl-2-naphthyl amine, di-1-naphthylamine, and di-2-naphthylamine; phenothazines such as N-alkylphenothiazines; imino(bisbenzyl); and hindered phenols such as 6-(t-butyl) phenol, 2,6-di-(t-butyl) phenol, 4-methyl-2,6-di-(t-butyl) phenol, 4,4'-methylenebis(2,6-di-{t-butyl} phenol), and the like.

Examples of suitable cuprous metal deactivators are imidazole, benzamidazole, 2-mercaptobenzthiazole, 2,5-dimercaptothiadiazole, salicylidine-propylenediamine, pyrazole, benzotriazole, tolutriazole, 2-methylbenzamidazole, 3,5-imethyl pyrazole, and methylene bis-benzotriazole. Benzotriazole derivatives are preferred. Other examples of more general metal deactivators and/or corrosion inhibitors include organic acids and their esters, metal salts, and anhydrides, e.g., N-oleyl-sarcosine, sorbitan mono-oleate, lead naphthenate, dodecenyl-succinic acid and its partial esters and amides, and 4-nonylphenoxy acetic acid; primary, secondary, and tertiary aliphatic and cycloaliphatic amines and amine salts of organic and inorganic acids, e.g., oil-soluble alkylammonium carboxylates; heterocyclic nitrogen containing compounds, e.g., thiadiazoles, substituted imidazolines, and oxazolines; quinolines, quinones, and anthraquinones; propyl gallate; barium dinonyl naphthalene sulfonate; ester and amide derivatives of alkenyl succinic anhydrides or acids, dithiocarbamates, dithiophosphates; amine salts of alkyl acid phosphates and their derivatives.

Examples of suitable lubricity additives include long chain derivatives of fatty acids and natural oils, such as esters, amines, amides, imidazolines, and borates.

Examples of suitable viscosity index enhancers include polymethacrylates, copolymers of vinyl pyrrolidone and methacrylates, polybutenes, and styrene-acrylate copolymers.

Examples of suitable pour point and/or floc point depressants include polymethacrylates such as methacrylate-ethylene-vinyl acetate terpolymers; alkylated naphthalene derivatives; and products of Friedel-Crafts catalyzed condensation of urea with naphthalene or phenols.

Examples of suitable detergents and/or dispersants include polybutenylsuccinic acid amides; polybutenyl phosphonic acid derivatives; long chain alkyl substituted aromatic sulfonic acids and their salts; and metal salts of alkyl sulfides, of alkyl phenols, and of condensation products of alkyl phenols and aldehydes.

Examples of suitable anti-foam agents include silicone polymers and some acrylates.

Examples of suitable anti-wear and extreme pressure resistance agents include sulfurized fatty acids and fatty acid esters, such as sulfurized octyl tallate; sulfurized terpenes; sulfurized olefins; organopolysulfides; organo phosphorus derivatives including amine phosphates, alkyl acid phosphates, dialkyl phosphates, aminedithiophosphates, trialkyl and triaryl phosphorothionates, trialkyl and triaryl phosphines, and dialkylphosphites, e.g., amine salts of phosphoric acid monohexyl ester, amine salts of dinonylnaphthalene sulfonate, triphenyl phosphate, trinaphthyl phosphate, diphenyl cresyl and dicresyl phenyl phosphates, naphthyl diphenyl phosphate, triphenylphosphorothionate; dithiocarbamates, such as an antimony dialkyl dithiocarbamate; chlorinated and/or fluorinated hydrocarbons, and xanthates.

Examples

Example 1

Critical flammability ratio (CFR) of mixtures determined using Underwriter Laboratories Refrigerant Flammability test method 2182. CFR allows determination of what level of flammable material can be incorporated, without the mixture itself becoming flammable. Butane and dimethyl ether (DME) were added to R-407C (23 wt.% R-32; 25 wt.% R-125 and 52 wt.% R-134a) as the flammable additive.

Temp. (°C)	Additive	Wt.%
25	Butane	3.4
60	Butane	3.1
100	Butane	2.5
25	DME	3.3
60	DME	2.7
100	DME	2.1

The table indicates that certain 32/125/134a/butane (or DME) compositions are nonflammable per the widely used refrigerant flammability method.

Example 2

Actual testing in a refrigeration machine of a composition of the invention (test mixture: 22.5 wt.% R-32, 24.5 wt.% R-125, 51 wt.% R-134a, 2 wt.% butane) was performed under typical air conditioning conditions and using mineral oil supplied by the compressor manufacturer (Copeland blended white oil Catalog No. 999-5170-31).

Testing was performed in a 2 ton air conditioner system setup similar to the unit reported in Report DOE/CE/23810-71 "Study of Lubricant Circulation in HVAC Systems," March 1995-April 1996 (author Frank R. Biancardi et. al.; prepared for Air Conditioning and Refrigeration Technology Institute Under ARTI/MCLR Project No. 665-53100) except that instead of equal size risers, three different size risers (3/4", 7/8" and 1 1/8") were used to allow a greater variety of velocities. Also the ability to pump oil from the compressor sump into the compressor discharge line was added. Using a hand pump, 90cc of oil from the sump was injected into the

compressor discharge line. By observing the oil level in the compressor sump versus time, the rate and time required for oil return was measured.

Composition	Capacity (tons)	COP	Oil return rate (cc/min)	Completion Time (min)
R-407C	1.70	2.9	2.4	65
Test Mixture	1.88	3.3	2.7	46

Oil return is important for compressor reliability purposes. The example demonstrates that both capacity and efficiency of the system are enhanced over R-407C in the absence of the solubilizing agent and the oil return is improved as well (in mineral oil systems).

Examples 3-7

The performance of mixtures of HFC refrigerant R-407C is obtained in the presence and absence of solublizing agents in a thermodynamic refrigeration cycle operating in typical air conditioning application (100°F condensing temperature and 40°F evaporating temperature). The vapor pressure of each mixture is measured at 25°C.

Ex. No.	32/125/134a Refrigerant Mixture (wt.%)	Solubilizing agent	Wt.%	Refrigeration Capacity relative to R-407C	Vapor Pressure relative to R-407C (25°C)	Oil Return
3	23/25/52 (R-407C)	--	0	1	1	No
4	21.9/23.8/49.3	Propane	5	1.05	1.05	Yes
5	21.9/23.8/49.3	Butane	5	1.00	0.99	Yes
6	22.6/24.5/51.0	Butane	2	1.00	1.00	Yes
7	20.9/22.7/47.4	Butane	10	1.00	0.98	Yes

Example 3 demonstrates that the HFC itself is unsuitable for use with hydrocarbon oil in that without oil return the compressor may be damaged.

Example 4 demonstrates that although there is oil return, the addition of propane results in an undesirable increase in the pressure of the system.

Examples 5-7 demonstrate that the use of butane results in oil return without an undesirable pressure increase. This is particularly important for retrofitting applications.

What is claimed is:

1. A composition comprising:

(i) a refrigerant selected from the group consisting of trichlorofluoromethane, dichlorodifluoromethane, chlorotrifluoromethane, tetrafluoromethane, dichlorofluoromethane, chlorodifluoromethane, trifluoromethane, dichloromethane, chlorofluoromethane, difluoromethane, chloromethane, fluoromethane, 1,1,2-trichloro-1,2,2-trifluoromethane, 1,2-dichloro-1,1,2,2-tetrafluoromethane, chloropentafluoroethane, hexafluoroethane, 2,2-dichloro-1,1,1,-trifluoroethane, 1-chloro-1,1,1,2-tetrafluoroethane, pentafluorethane, 1,1,1,2-tetrafluoroethane, 1,1-dichloro-1-fluoroethane, 1,chloro-1,1-difluoroethane, 1,1,1-trifluoroethane, octafluoropropane, 1,1,1,2,3,3,3-heptafluoropropane, 1,1,1,3,3,3-hexafluoropropane, 1,1,1,3,3-pentafluoropropane, 1,1,1,3,3–pentafluorobutane, and octafluorocyclobutane, and mixtures of two or more thereof; and

(ii) a solubilizing agent selected from the group consisting of dichloromethane, chloromethane, methane, ethane, propane, butane, isobutane, pentane, isopentane, neopentane, cyclopentane, iodotrifluoromethane, pentafluorodimethyl ether, 1,1-difluoroethane, fluoroethane, hexafluoroethane, dimethyl ether, ethyl ether, polybutylene glycols, methyl formate, carbon dioxide, sulfur hexafluoride, ethylene, propylene, and mixtures of two or more thereof.

2. The composition of claim 1 wherein the refrigerant comprises a compound selected from the group consisting of R-32, R-125, R-134a, R-143a and mixtures of two or more thereof.

3. The composition of claim 1 wherein the refrigerant is a mixture of R-32, R-125 and R-134a.

4. The composition of claim 1 wherein the refrigerant is a mixture of R-32 and R-125.

5. The composition of claim 1 wherein the refrigerant is a mixture of R-143a, R-125 and R-134a.

6. The composition of claim 1 wherein the refrigerant is a mixture of R-125 and R-143a.

7. The composition of claim 1 wherein the refrigerant is selected from the group consisting of R-400, R-401A, R-401B, R-401C, R-402A, R-402B, R-403A, R-403B, R-404A, R-405A, R-406A, R-407A, R-407B, R-407C, R-407D, R-407E, R-408A, R-409A, R-409B, R-410A, R-410B, R-411A, R-411B, R-412A, R-413A, R-414A, R-414B, R-500, R-501, 4-502, R-503, 4-504, R-505, R-506, R-507A, R508A, R-508B, R-509A, and mixtures of two or more thereof.

8. The composition of claim 1 wherein the refrigerant is selected from the group consisting of R-404A, R-407C, R-410A and R-507A.

9. The composition of claim 1 wherein the refrigerant is selected from the group consisting of:

(a) a mixture of from 10 to 80 wt.% R-32 and from 90 to 20 wt.% R-125;

(b) a mixture of from 5 to 45 wt.% R-32, from 5 to 45 wt.% R-125 and from 90 to 10 wt.% R-134a;

(c) a mixture of from 30 to 90 wt.% R-125 and from 70 to 10 wt.% R-143a; and

(d) a mixture of from 60 to 40 wt.% R-125, from 39 to 20 wt.% R-143a, and from 2 to 40 wt.% R-134a.

10. The composition of any one of claims 1-9 wherein the solubilizing agent is butane.

11. The composition of any one of claims 1-9 wherein the solubilizing agent is isobutane.

12. The composition of any one of claims 1-9 wherein the solubilizing agent is pentane.

13. The composition of any one of claims 1-9 wherein the solubilizing agent is dimethyl ether.

14. The composition of claim 1 further comprising a lubricating oil selected from the group consisting of mineral or hydrocarbon oil, alkyl benzene oil, white or paraffinic oil and mixtures thereof.

15. A method for producing refrigeration which comprises condensing the composition of claim 1 and thereafter evaporating the composition in the vicinity of a body to be cooled.

16. A method for producing heating which comprises condensing the composition of claim 1 in the vicinity of a body to be heated and thereafter evaporating the composition.

17. A process for heating or cooling comprising the step of using the mixture of claim 1 as a heat transfer media.

18. A sterilizing gas composition comprising effective amounts of the composition of claim 1 and ethylene oxide.

19. A method of sterilizing articles comprising exposing the articles to the sterilizing gas composition of claim 18.

20. A method of dissolving contaminants or removing contaminants from the surface of a substrate which comprises the step of using a composition comprising the composition of claim 1 as a solvent.

21. A process for suppressing a fire comprising a step of using the mixture of claim 1 as a fire extinguishing agent.

22. A blowing agent composition comprising the composition of claim 1.

23. A method for producing polyurethane and polyisocyanurate foams comprising reacting and foaming a mixture of ingredients that react to form the polyurethane and polyisocyanurate foams in the presence of a volatile blowing agent comprising the composition of claim 1.

24. A premix of a polyol and a blowing agent comprising the composition of claim 1.

25. A closed cell foam composition prepared by foaming a polyisocyanate or polyisocyanurate in the presence of a blowing agent comprising the composition of claim 1.

26. A process for atomizing a fluid comprising using the composition of claim 1 as an aerosol propellant.

27. A process for electrically insulating comprising using the composition of claim 1 as a gaseous dielectric.

28. A method of recharging a refrigeration system of the type containing a chlorine-containing refrigerant and a lubricating oil, comprising the steps of:

(a) removing said chlorine-containing refrigerant from said refrigeration system while leaving substantially all of said lubricating oil in said system; and

(b) introducing to said lubricating oil left in said system the composition of claim 1.